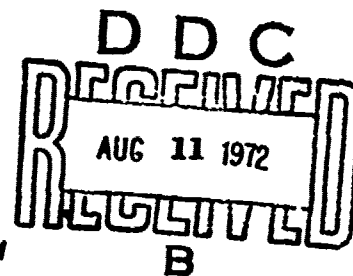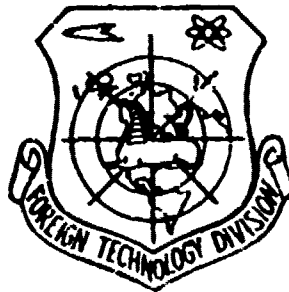AD 746266

FOREIGN TECHNOLOGY DIVISION

MANUFACTURE OF PARTS USING THE METHOD OF
HYDROSTATIC EXTRUSION

by

A. A. Galkin, V. P. Buryak,
Ye. I. Osyka, B. M. Lisovskiy, et.al.

DDC

AUG 11 1972

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DOCUMENT CONTROL DATA - R & D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1. ORIGINATING ACTIVITY (Corporate author)	2a. REPORT SECURITY CLASSIFICATION
Foreign Technology Division Air Force Systems Command U. S. Air Force	UNCLASSIFIED
	2b. GROUP

3. REPORT TITLE

MANUFACTURE OF PARTS USING THE METHOD OF HYDROSTATIC EXTRUSION

4. DESCRIPTIVE NOTES (Type of report and inclusive dates)

Translation

5. AUTHOR(S) (First name, middle initial, last name)

Galkin, A. A.; Buryak, V. P.; Osyka, Ye. I.; Lisovskiy, B. M.; Matrosov, N. I.; and Kovalenko, V. G.

6. REPORT DATE	7a. TOTAL NO. OF PAGES	7b. NO. OF REFS
1969	7	7

8a. CONTRACT OR GRANT NO.	9a. ORIGINATOR'S REPORT NUMBER(S)
b. PROJECT NO. 601080	FTD-HC-23-332-71
c.	9b. OTHER REPORT NO(S) (Any other numbers that may be assigned this report)
d. DIA Task No. T69-01-82	

10. DISTRIBUTION STATEMENT

Approved for public release; distribution unlimited.

11. SUPPLEMENTARY NOTES	12. SPONSORING MILITARY ACTIVITY
	Foreign Technology Division Wright-Patterson AFB, Ohio

13. ABSTRACT

The authors study equipment designed and used for the hydro-extrusion of industrial shaped products. The new unit operates at 30,000 bar as opposed to the older unit studied by the authors which operated at 20,000 bar. It consists of an attachment incorporating a container coupled to a presser generator by a plunger. A P477A 100 ton force vertical hydraulic press or a D0437 500 ton force press can serve as the presser generator. Gasoline, gasoline and oil, kerosene and oil, and various mixtures of these were used for the working fluid with friction reducing additives. MoS(subscript 2) was used for lubrication with various modifications. () The optimum entrance cone of the female die was 20 plus 40 degrees. The billet end was ground to an angle equal to that of the female die cone. Circular, rectangular, and spiral industrial shaped products were extruded from nonferrous metals, construction and tool grades of steel, and from hard to form alloys. The dimensions of these products were limited by the available containers and did not exceed 12 mm diameter and 150 mm in length. The results show that extrusion requires more force, requiring equipment which can operate at higher pressures. [AR0027854]

DD FORM 1473 (1 NOV 65)

KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Hydrostatic Extrusion						
Material Deformation						
Nonferrous Metal Alloy						
Nonferrous Metal						
Ferrous Metal						

EDITED TRANSLATION

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English pages: 7

Source: Kuznechno-Shtampovochnoye
           Proizvodstvo (Forging and Stamping)
           1969, No. 6, pp. 11-13

Translated under: F33657-71-D-0057

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distribution unlimited.

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Along with the widespread use of methods of producing profiled parts from nonferrous and ferrous metals as well as alloys, interest has developed in a new method of working metals by pressure — the method of hydroextrusion. It is characterized by improved methods of extruding the part through the eye of the matrix. Hydroextrusion is the only rational method of working when manufacturing profiles from materials which are difficult to deform.

The system for extruding profiled parts using fluid under high pressure is the same as the methods for extruding rod-shaped parts, described in the literature [1-4]. The effect of pressure on the mechanical properties of the deformed materials is described in [1,3].

The present article describes an apparatus developed and used for hydroextrusion of profiled part

The description does not include the apparatus used in the early stages of the studies, operating at pressures up to 20,000 bars. The apparatus for hydroextrusion at pressures up to 40,000 bars (Figure 1)
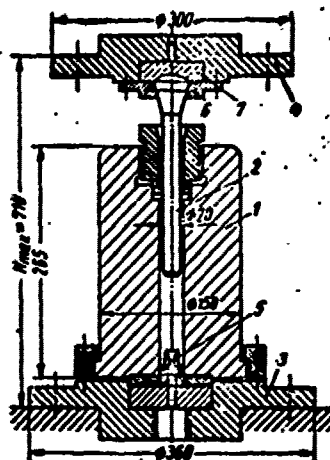
consists of a press attachment, made up of a container 1, connected by a plunger 2 to the pressure generator. The pressure generator is a vertical hydraulic press with a force of 100 tons (Type D 0437).

The pressure in the container is related to the pressure in the cylinder of the press by the relationship

$$p_\kappa = p k_\kappa k_f,$$

Figure 1.

where k_m is the coefficient of multiplication; k_f is a coefficient which accounts for the losses in pressure transmission; its value depends on the type of compression of the plunger, the working pressure and the fluids and lubricants used; k_f = 8 to 20%. The apparatus is mounted on two plates 3 and 4, connected to the upper and lower braces of the press. The container is mounted on the spherical surface of a bearing 7 and attached to the place by a clamp 6.

The working fluid is benzine + oil, kerosene + oil and various mixtures with additives, reducing friction and producing comparatively low extrusion forces. The fluid is poured in at the top with the plunger completely withdrawn.

To reduce friction and cut down the extrusion forces, lubricants are employed: MoS_2 in various modifications, hypoid, graphite; lead, zinc and cadmium coatings.

The optimum angle for the inlet cone of the matrix 5 was 20 + 40°. The blank had a sharpening angle equal to the angle of the cone of the matrix, while a shaft projecting into the calibrating portion with a small clearance was provided for more reliable sealing and accurate centering along the axis of the matrix.

The hydroextrusion process takes place at great speed. With the
speed of the press not regulated, it is impossible to regulate the
flow process, so that there is difficulty in collecting the parts.
This is particularly evident if the volume of the liquid is considerably
in excess of the volume of the blank. However, if the volume of the
liquid is comparable to the volume of the blank, then as the parts
emerge from the press, it will not be possible to maintain the pressure
necessary for extrusion, and the process will cease until the pressure
builds up again.

To reduce the influence of the accumulated energy of the compressed
fluid on the rate of output of the extrudate and the hydraulic system
of the press, tests were made involving closing the internal channel
of the container following emergence of the part. As a result of the
press, tests were made involving closing the internal channel of the
container following emergence of the part. As a result of the tests,
it was concluded that disk-shaped irregular, spherical and conical
sections have a positive effect on the operation of the press, insig-
nificantly reducing the rate of output of the extrudate, but reduce
the service life of the matrix, especially at high pressures, when
the energy of the impact of the cross section against the matrix in-
creases considerably. To collect the parts emerging from the container
at high speed, catchers were used with rubber, cloth or other liners,
partly solving the problem of braking. Pneumatic and hydraulic
catchers were tested.

This device was used for the extrusion of parts with circular,
rectangular and helical cross sections from nonferrous metals, struc-
tural and tool steels and alloys that were difficult to deform. The
dimensions of the parts produced were limited by the available con-
tainers and amounted to a maximum of 12 mm in diameter and 150 mm
in length.

The container is a single-layer thin-walled cylinder with a
ratio of the radii $R/r = 8:10$, autofretted by hydrostatic pressure in
excess of the working pressure by 15% and working in an elastic-plastic
range. The calculations for the strength of thin-walled vessels are
discussed in detail in [5, 7].

Measurements made of the internal channel of the container following 15 cycles of stress up to 30,000 bars showed that no further increase in the diameter had taken place. This is supported by the results of the work in [6], indicating that plastic deformations are damped with an increase in the number of stresses. Vessels are also used in which the plastic deformation amounts to 4-6% ($\Delta r/r \cdot 100$).

From the experience gained in working with multilayer and single-layer containers, we can conclude that of all the high-pressure containers of current design that operate at pressures up to 30,000 bars, it is best to use single-layer ones.

Experiments were conducted to study the influence of thermal working of the material on the strength of the container. An optimum regime for thermal working of 45 KhNVA, 45 KhNMFA and 45 KhNVFA steels was worked out; these steels are used for manufacture of single-layer containers, used at room temperature. Thermal working up to hardness HRC 39-42 insures high strength of the container.

For working at 500° C, one can use highly alloyed heat-resistant steels (Kh4V2FM, 3 Kh2N2MVF, 3 Kh2V8F, EI958 and Kh6V3FM). The container operates in the elastic-plastic zone, and its working channel has a curved shape, so that a gasket seal was chosen.

In this case, there is no need for a precise working of the internal channel of the container or for fitting it with a working rod; the stress on the rod during longitudinal bending is more favorable; the gasket seal has a long service life.

There are many types of gasket seals. The majority of them consist of a large number of rings, requiring precise working and careful fitting. We tested several varieties of gasket seals and studied the effect of a gap between the moving parts on the mass of the rings.

The simplest seal consists of five rings (Figure 2). Clamping ring 1 is made with a high degree of precision from ShKh15 steel
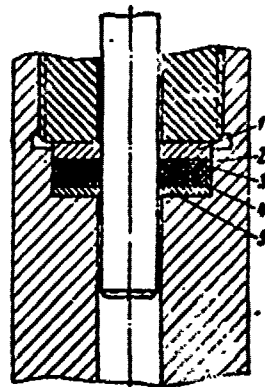
Figure 2.

(HRC 60-65). The clamping ring forms a gap of 0.01-0.02 mm with the plunger, and 0.015-0.025 mm in the socket. Packing rings 2, 3 and support 5 are made of Br.B2 bronze (HRC-35-40).

Teflon is used for sealing ring 4. The ring is made with a clearance of 0.1-0.2 mm relative to the plunger and the socket. The surface life of the packing is determined by the strength of ring 5 and is in the hundreds of cycles.

Type ShKh15, KhVG and R 18 steels are used to make the plunger; in working with pressures above 25,000 bars, it is preferable to use R18 steel. At 700° C, use of R/T and 7Kh4V7FM steel may be recommended.

In extruding profiled parts, certain difficulties may be encountered in preparing the matrix. Matrices made of ShKh15, 3Kh2V8F, E1958 and other high-strength steels, as well as refractory steels, are used. Matrices used to make parts with circular and rectangular cross sections are made by a mechanical method, while profiled matrices are made by the electroerosion method or by stamping from cermet alloys.

Refractory matrices are more advantageous, since they are simple to make, have long service lives and provide the required quality of the surface of the emerging extrudate.

The sealing of matrices with a cylindrical outer surface is shown in Figure 3. This kind of sealing is also used for matrix 3 with a nonworked surface and may be employed at pressures up to 30,000 bars. Support ring 1, used for sealing, is made of bronze or brass with a
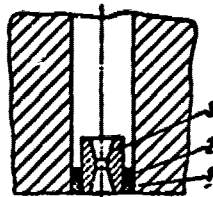
clearance of 0.01 relative to the matrix and the container. Packing ring 2 (Teflon) is made with a clearance of 0.2 mm relative to the diameters.

RESULTS

Figure 3.

Pressing profiles requires high forces, thus creating the necessity for an apparatus working at higher pressures. The use of high-strength ductile steels with a special preliminary hydraulic working of the internal channel makes it possible to use a container with a single-layer construction at room temperature for pressures up to 40,000 bars.

Containers with large diameters for the internal channel for pressures up to 40,000 bars may be made with two-layer construction, made up of two inserts with a slight gap.

It is necessary to continue work in the area of reducing the rate of out-put of extrudate and in working out designs for capturing the latter and slowing it down in ordinary industrial hydraulic presses. In addition, it is necessary to develop a design for compacting the rod and matrix, insuring a long continuous service at a pressure of 30,000 bars and a temperature of 500° C.

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